SB
952
.D2
P43
1947

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project 1-C-2-15 Date September 25, 1947 Author

TITLE

Part I

PRELIMINARY INVESTIGATIONS OF THE RESIDUAL EFFECT OF DDT AND OTHER INSECTICIDES ON THE CALIFORNIA FIVE-SPINED ENGRAVER BEETLE IPS CONFUSUS (LEC.) AND THE WESTERN PINE BEETLE DENDROCTONUS BREVICOMIS LEC.

Part II

PRELIMINARY INVESTIGATIONS OF THE RESIDUAL EFFECT OF DDT AND OTHER INSECTICIDES ON THE CALIFORNIA FIVE-SPINED ENGRAVER BEETLE IPS CONFUSUS (LEC.) AND THE WESTERN PINE BEETLE DENDROCTONUS BREVICOMIS LEC.

by

Albert S. Perry
Field Aide - SP-6
U.S. Forest Service

Forest Insect Laboratory
341 Giannini Hall, U.C.
Berkeley, California

SUBJECT—

INDEX NO.—

U. S. GOVERNMENT PRINTING OFFICE 16—47272-1

Part I

PRELIMINARY INVESTIGATIONS OF THE RESIDUAL EFFECT OF DDT AND OTHER INSECTICIDES ON THE CALIFORNIA FIVE-SPINED ENGRAVER BEETLE IPS CONFUSUS (LEC.) AND THE WESTERN PINE BEETLE DENDROCTONUS BREVICOMIS LEC.

Part II

PRELIMINARY INVESTIGATIONS OF THE RESIDUAL EFFECT OF DDT AND OTHER INSECTICIDES ON THE CALIFORNIA FIVE-SPINED ENGRAVER BEETLE IPS CONFUSUS (LEC.) AND THE WESTERN PINE BEETLE DENDROCTONUS BREVICOMIS LEC.

by
Albert S. Perry
Field Aide - SP-6
U.S. Forest Service

Berkeley, California
September 25, 1947

Part I

Preliminary investigations of the residual effect of DDT and other insecticides on the California five-spined engraver Ips Confusus (Lec.), and the Western pine beetle Dendroctonus brevicomis Lec.

Introduction

Very little is known at the present time about the residual effect of DDT and other insecticides on bark beetles.

The work done in the past was centered mainly on the use of heavy applications of DDT/oil solutions with the object of killing the brood under bark. As much as 4 oz. of 5% DDT per sq. ft. was applied. While this may be of value in investigations under laboratory conditions, the practicability of this sort of application for control work in the field is rather doubtful.. At this rate of application it would take 3 gal. of diesel oil + 1¼ lbs. of DDT to treat an average amount of slash of 100 ft. of bark surface at a cost of $1.11 per 100 board ft. for the materials alone, not to mention the cost of man hours for the application. For this reason it was thought desirable of setting up some preliminary experiments to determine if light applications of concentrated sprays under laboratory conditions would give satisfactory results in controlling the emerging parent and callow adults. The present preliminary investigations point in this direction.

Materials and equipment

The insecticides used in this work were as follows:
(1) 15% DDT in Diesel-oil #2
(2) 15% DDT in Kerosene
(3) 12.5% DDT in water (Gesarol E-25)
(4) 5% 1068 (Okta Klor) in Kerosene
(5) 2% 666, wettable (Benzene hexachloride, 5% Gamma isomer)
(6) 2% Genicide "A", wettable (xanthone + DDT)
Series I was sprayed with a Hudson sprayer; Series II with the High-Fog sprayer and Series III with a paint spray gun.

Procedure

Tops of infested trees were cut into sections, each section measuring 10" - 18" long and 7" - 9" in diameter and having a bark area of approximately 3 sq. ft.

The sections were paired at random and each pair received a different treatment.

The rate of application for Series I and II was determined in terms of spraying time per unit area and the dosages applied were rated as Light,

Medium and Heavy.

The randomized paired sections were treated as follows:

Sample No.	Sections	Formula	No. of cc./sq.ft.	Gms.DDT/sq.	Rating
D_1	1B - 2A	DDT-Diesel	5.1	0.63	Light
D_2	1F - 2E	" "	9.3	1.16	Medium
D_3	1G - 2B	" "	16.1	2.00	Heavy
W_1	1A - 2G	DDT-Water	5.1	0.63	Light
W_2	1E - 2D	" "	9.3	1.16	Medium
W_3	1C - 2F	" "	16.1	2.00	Heavy
C	1D - 2C	Check	--	---	---

Series III was sprayed with a modified paint spray gun. A vial 60 cc. in capacity was fastened to the bottom of the spray container and the volume of spray was accurately measured for each application.

The paired sprayed sections were placed in cages 6' x 3' x3' made of a wooden frame and covered all around with cheesecloth.

A section of non-enfested wood of approxiamtely the same size was placed alongside the sprayed sections in each cage.

A check was kept for each experiment. In this case the infested sections were not sprayed and were placed in the cage together with a non-infested log.

The cages were checked daily for dead beetles and for attacks on the healthy wood. At the conclusion of the experiment usually from 7-10 days, the bark was peeled off the originally non-infested sections and the number of attacks determined.

In series II the no. of eggs laid by each family was also determined.

Data

SERIES I

TABLE I

Sample No.	Formula	Rating	No. of dead	8/6/47 No. of attacks on healthy wood
D_1	DDT-Diesel	Light	24	0
D_2	"	Medium	37	0
D_3	"	Heavy	19	0
W_1	DDT-Water	Light	39	0
W_2	"	Medium	65	0
W_3	"	Heavy	52	0
Check		---	11	0

TABLE II

Sample No.	Formula	Rating	No. of dead	8/7/47 No. of attacks on healthy wood
D_1	DDT-Diesel	Light	8	0
D_2	" "	Medium	13	0
D_3	" "	Heavy	0	0
W_1	DDT-Water	Light	36	0
W_2	" "	Medium	21	0
W_3	" "	Heavy	22	0
Check	----	---	5	1

TABLE III

Sample No.	Formula	Rating	No. of dead	8/8/47 No. of attacks on healthy wood
D_1	DDT-Diesel	Light	5	0
D_2	"	Medium	12	0
D_3	"	Heavy	3	0
W_1	DDT-Water	Light	23	0
W_2	"	Medium	24	0
W_3	"	Heavy	10	0
Check	---	---	4	3

TABLE IV

Sample No.	Formula	Rating	No. of dead	No. of attacks on healthy wood
D_1	DDT-Diesel	Light	20	0
D_2	"	Medium	21	6
D_3	"	Heavy	3	0
W_1	DDT-Water	Light	35	0
W_2	"	Medium	40	0
W_3	"	Heavy	26	2
Check	----	---	4	14

TABLE V — Summary of Series I

Sample No.	Total No. of dead	Total No. of attacks	Total No. of live beetles	Average no. of beetles per attack
D_1	57	0	0	0
D_2	83	6	12	2
D_3	25	0	0	0
W_1	133	0	0	0
W_2	150	0	0	0
W_3	110	2	5	2.5
Check	24	18	43	2.4

Series II

TABLE VI

Sample No.	Formula	Rating	no. of dead	8/19/47 No. of attacks on healthy wood
D_1	DDT-Diesel	Light	41	3
D_2	"	Medium	34	0
D_3	"	Heavy	27	3
W_1	DDT-Water	Light	18	0
W_2	"	Medium	63	1
W_3	"	Heavy	27	1
Check	---	---	5	12

TABLE VII

Sample No.	Formula	Rating	No. of dead	8/20/47 No. of attacks on healthy wood
D_1	DDT-Diesel	Light	13	3
D_2	"	Medium	15	0
D_3	"	Heavy	13	0
W_1	DDT-Water	Light	11	0
W_2	"	Medium	29	0
W_3	"	Heavy	14	0
Check	---	---	1	11

TABLE VIII

Sample No.	Formula	Rating	No. of dead	8/21/47 No. of attacks on healthy wood
D_1			7	1
D_2			9	1
D_3			10	1
W_1			6	1
W_2			30	1
W_3			8	0
Check			0	18

TABLE LX

Sample No.	No. of dead	8/22/47 No. of attacks on healthy wood
D_1	6	1
D_2	7	0
D_3	6	0
W_1	0	0
W_2	16	0
W_3	7	0
Check	1	5

TABLE X

Sample No.	No. of dead	8/25/47 No. of attacks on healthy wood
D_1	11	1
D_2	12	0
D_3	11	0
W_1	9	1
W_2	32	0
W_3	11	0
Check	1	17

SUMMARY OF RESULTS OF SERIES II

TABLE XI

Sample No.	Total no. of dead	Total no. of attacks	Total no. of live beetles	Average no. of beetles per attack	Total no. of eggs	Average no. of eggs per beetle
D_1	78	9	18	2	108	6
D_2	77	1	1	1	0	0
D_3	67	4	6	1.5	3	0.5
W_1	44	2	3	1.5	5	1.7
W_2	170	2	2	1	0	0
W_3	67	1	3	3	11	3.7
Control	8	63	168	2.7	1220	7.3

Discussion

In this series of experiments it was intended to similate field conditions as much as possible. As a consequence, the object was to determine the ability of Ips confusus to attack healthy wood after their emergence from the sprayed sections.

The results of Series I (Table V) and Series II (Table XI) show that there was no definite correlation between dosage, mortality and number of atttacks.

From this, one may conclude that the light application was sufficient to give good coverage under the conditions of the test. However, from a practical point of view, this is not so, for the volume applied for the light application i.e., 5 cc. per sq. ft. was barely sufficient to cover the entire bark surface. It may be safe to assume that the heavy dosage under field conditions would approach that of the medium dosage under laboratory conditions.

A further analysis of the data shows that a fair degree of control was obtained in both Series I and II. The degree of control was measured here in terms of the average number of attacks per sq. ft. of bark and of the average number of dead beetles per sq. ft. of bark. In Series I the total number of attacks for the sprayed sections was 8 or an average of 0.44 attacks per sq. ft., and the number of dead beetles was 558 or an average of 31 dead beetles per sq. ft. The control for Series I showed an average of 6 attacks per sq. ft. and an average of 8 dead beetles per sq. ft. (Table V). In Series II the total number of attacks for the sprayed sections was 19 or an average of 1.05 attacks per sq. ft. and the number of dead beetles was 503 or an average of 28 dead beetles per sq. ft. The control for Series II showed an average of 21 attacks per sq. ft. and an average of 2.6 dead beetles per sq. ft. (Table XI).

An interesting observation was made with regard to the number of eggs laid. For the sprayed sections in Series II the total number of eggs laid was 127 or 3.8 eggs per live beetle. In contrast the control showed a total of 1220 eggs or 7.3 eggs per live beetle (Table XI).

Another point worth mentioning is the fact that the tunnels built by the attacking beetles in the sprayed sections were considerably smaller than those in the cntrol.

From all indications the results obtained in these experiments seem quite promising. From the standpoint of cost it would take 3.3 pints of Diesel oil and 0.44 lbs. of DDT to treat an average amount of slash of 100 ft.

of bark surface at a cost of $0.37 per 100 board feet for the materials only. The cost of application would also be much cheaper than with the alternate method of applying a large volume of spray at a lower concentration.

There are a number of powerful insecticides in the market at the present time which may prove very effective in the control of bark beetles, and with the more recent methods of application of insecticide concentrates it is undoubtedly justifiable to continue control investigations along these lines.

Series III involving the other insecticides mentioned is still in progress and an evaluation of the results will be reported later.

PART II

Preliminary investigations on the residual effect of DDT and other insecticides on the California five-spined engraver beetle Ips Confusus (Lec.) and the Western Pine beetle Dendroctonus brevicomis Lec.

Introduction

This series of tests is essentially the same as those discussed in Part I except that here sections of healthy wood were sprayed with the various insecticides used and the test insects were introduced into the cages.

The object here, was to find out if the insects would survive after coming in contact with the spray residues, and if forced attacks could be induced under the conditions of the tests.

Materials and equipment

The insecticides used in this study were as follows:

15% DDT in Diesel oil #2
15% DDT in Kerosene
12.5% DDT in Water (Gesarol E-25)
5% 1068 (Okta-Klor)
2% Genicide "A", wettable (Xanthone + DDT)
2% 666 wettable (Benzene hexachloride, 5% Gamma isomer)

The spraying was done with a paint spray gun connected to a small compressor for air supply. A small vial 25 cc. in capacity was fastened to the bottom of the spray gun container and this enabled the measurement and application of small quantities of spray with a great degree of accuracy.

Procedure

The method of testing employed was to cut small triangular blocks of healthy wood measuring approximately 3"x2"x2" and having a surface area of approximately 24 sq. in. Each block was sprayed with 5 cc. of the spray solution and placed in a fibreboard can of one pint capacity which was also sprayed with 5 cc. of the spray in question. Two to three hours after spraying fifteen beetles were introduced into each can and the top of the can was covered with cheesecloth secured by a rubber band. A series of checks was kept for each experiment and in this case the blocks and cages were sprayed with only the solvent of the corresponding insecticide, i.e., either diesel or kerosene. The beetles were freshly collected for each experiment from infested trees brought from the field and kept in rearing cages in the insectary.

Mortality counts were taken at intervals of 12, 24, and 48 hours. In several cases, using the western pine beetle Dendroctonus brevicomis as the test insect, mortality counts were taken up to 72 hours.

Experimental results with Ips Confusus (Lec.)

Series A

Table I

Materials	No.of Insects	No. of Dead 12hrs.	24hrs.	48hrs.	% Kill 12hrs.	24hrs.	48hrs.	Remarks
DDT-Diesel	15	1	4	15	6.6	26.6	100	
"	"	4	6	15	26.6	40.0	100	
"	"	3	6	15	20.0	40.0	100	
DDT-Kerosene	"	1	8	15	6.6	53.2	100	
"	"	4	13	15	26.6	86.4	100	
"	"	0	11	15	0	73.2	100	
DDT-Water	"	2	8	15	13.3	53.2	100	
"	"	3	11	15	20.0	73.2	100	
"	"	5	9	14	33.3	59.8	93.4	
DDD	"	1	1	5	6.6	6.6	33.3	
"	"	2	3	8	13.3	20.0	53.2	
"	"	3	3	5	20.0	20.0	33.3	
1068	"	5	11	15	33.3	73.2	100	
"	"	12	15	15	79.8	100	100	
"	"	8	12	15	53.2	79.8	100	
666	"	8	14	15	53.2	93.4	100	
"	"	8	14	15	53.2	93.4	100	
"	"	12	15	15	79.8	100	100	
Genicide	"	3	10	12	20.0	66.6	79.8	
"	"	1	5	8	6.6	33.3	53.2	
"	"	3	5	10	20.0	33.3	66.6	
Check	"	0	0	1	0	0	6.6	
"	"	0	0	4	0	0	26.6	
"	"	0	0	3	0	0	20.0	
"	"	0	0	0	0	0	0	

Series B

Table II

Materials	No. of insects	No. of Dead 12hrs.	24hrs.	48hrs.	% Kill 12hrs.	24hrs.	48hrs.	Remarks
DDT-Diesel	15	9	10	15	59.8	66.6	100	
"	"	9	14	15	59.8	93.4	100	
"	"	8	12	15	53.2	99.8	100	
DDT-Kerosene	"	11	14	15	73.2	93.4	100	
"	"	5	10	15	33.3	66.6	100	
"	"	7	13	14	46.6	86.4	93.4	
DDT-Water	"	2	6	14	13.3	40.0	93.4	
"	"	6	11	12	40.0	73.2	79.8	
"	"	7	12	14	46.6	79.8	93.4	
DDD	"	7	8	13	46.6	53.2	86.4	1 attack
"	"	9	10	11	59.8	66.6	73.2	2 attacks
"	"	4	7	13	26.6	46.6	86.4	1 attack
1068	"	0	6	12	0	40.0	79.8	1 attack
"	"	2	5	13	13.3	33.3	86.4	
"	"	2	7	13	13.3	46.6	86.4	1 attack
666	"	6	13	14	40.0	86.4	93.4	1 attack
"	"	10	15	15	66.6	100	100	
"	"	8	12	15	53.2	79.8	100	
Genicide	"	0	3	5	0	20.0	33.3	4 attacks
"	"	1	4	9	6.6	26.6	59.8	4 attacks
"	"	1	1	4	6.6	6.6	26.6	4 attacks
Check	"	0	0	0	0	0	0	4 attacks
"	"	0	0	0	0	0	0	3 attacks
"	"	0	0	0	0	0	0	4 attacks
"	"	0	0	0	0	0	0	4 attacks

Series C

Table III

Materials	No. of insects	No. of Dead 12hrs.	24hrs.	48hrs.	% Kill 12hrs.	24hrs.	48hrs.	Remarks
DDT-Kerosene	10	0	4	10	0	40	100	
"	"	5	6	10	50	60	100	
"	"	3	7	10	30	70	100	
1068 + DDT	"	0	4	9	0	40	90	
"	"	3	7	9	30	70	90	
"	"	0	6	10	0	60	100	
666	"	3	9	10	30	90	100	
"	"	2	7	10	20	70	100	1 attack
"	"	4	8	9	40	80	90	1 attack
Check	15	0	0	0	0	0	0	4 attacks
"	15	0	0	0	0	0	0	3 "
"	15	0	0	0	0	0	0	6 "

Experimental results with Dendroctonus brevicomis Lec.

Series D

Table IV

Materials	No. of insects	No. of dead				% Kill				Remarks
		12hrs.	24hrs.	48hrs.	72hrs.	12hrs.	24hrs.	48hrs.	72hrs.	
DDT-Diesel	15	0	1	5	14	0	6.6	33.3	93.4	
"	"	1	1	3	10	6.6	6.6	20.0	66.6	
"	"	1	2	5	14	6.6	13.3	33.3	93.4	
DDT-Kerosene	"	0	2	5	--	0	13.3	33.3	--	
"	"	0	1	5	--	0	6.6	33.3	--	
"	"	0	1	6	--	0	6.6	40.0	--	
DDT-Water	"	0	0	1	8	0	0	6.6	53.2	
"	"	1	1	4	11	6.6	6.6	26.6	73.2	
"	"	0	0	3	9	0	0	20.0	59.8	
DDD	"	0	0	0	4	0	0	0	26.6	1 attack
"	"	0	0	0	5	0	0	0	33.3	very activ
"	"	0	1	2	5	0	6.6	13.3	33.3	very active
1068	"	1	1	9	--	6.6	6.6	59.8	--	
"	"	0	0	4	--	0	0	26.6	--	2 attack
"	"	0	0	11	--	0	0	73.2	--	
666	"	0	0	4	--	0	0	26.6	--	
"	"	0	0	5	--	0	0	33.3	--	
"	"	0	1	1	--	0	6.6	6.6	--	
Genicide	"	0	0	4	--	0	0	26.6	--	2 attacks
"	"	2	4	6	--	13.2	26.4	40.0	--	4 attacks
"	"	0	0	0	--	0	0	0	--	
1068 + DDT	"	0	0	8	--	0	0	53.2	--	
"	"	1	2	9	--	6.6	13.3	59.8	--	
"	"	0	2	8	--	0	13.3	53.2	--	
Check	"	0	1	2	--	0	6.6	13.3	--	1 attack
"	"	0	1	1	--	0	6.6	6.6	--	1 "
"	"	0	0	1	--	0	0	6.6	--	4 attacks
"	"	0	0	1	--	0	0	6.6	--	3 "

Series E

Table V

Materials	No. of insects	No. of Dead				% Kill				Remarks
		12 hrs.	24hrs.	48hrs.	72hrs.	12hrs.	24hrs.	48hrs.	72hrs.	
DDT-Diesel	10	0	0	5	8	0	0	50	80	
"	"	0	0	3	8	0	0	30	80	
"	"	0	0	2	9	0	0	20	90	
DDT-Kerosene	"	0	0	5	--	0	0	50	--	
"	"	0	0	7	--	0	0	70	--	
"	"	0	0	7	--	0	0	70	--	
DDT-Water	"	0	0	3	9	0	0	30	90	
"	"	0	0	5	9	0	0	50	90	
"	"	0	0	4	8	0	0	40	80	
DDD	"	0	0	1	1	0	0	10	10	
"	"	0	0	0	3	0	0	0	30	1 attack
"	"	0	0	2.	4	0	0	20	40	
1068	"	0	0	4	5	0	0	40	50	
"	"	0	0	3	7	0	0	30	70	
"	"	0	0	3	7	0	0	30	70	
666	"	0	1	8	--	0	10	80	--	
"	"	0	1	7	--	0	10	70	--	
"	"	1	2	8	--	10	20	80	--	
1068 + DDT	"	0	0	5	--	0	0	50	--	
"	"	0	0	7	--	0	0	70	--	
"	"	0	1	8	--	0	10	80	--	
Check	"	0	0	0	--	0	0	0	--	
"	15	0	0	0	--	0	0	0	--	3 attacks
"	"	0	0	0	--	0	0	0	--	1 attack
"	"	0	0	0	--	0	0	0	--	1 attack

Summary of results with Ips confusus (Lec.)
(Based on Tables I, II, and III)

Table VI

Materials	Total No. of insects	Total No. of Dead 12hrs.	24hrs.	48hrs.	Average % Kill 12hrs.	24hrs.	48hrs.	No. of attacks
DDT-Diesel (15%)	90	34	52	90	36.1	57.7	100	0
DDT-Kerosene (15%)	120	36	86	119	29.6	69.8	99.2	0
DDT-Water (12.5%)	90	25	57	84	27.7	63.2	93.3	0
DDD (15%)	90	26	32	55	28.8	35.5	61.0	4
1068 (5%)	90	29	56	83	32.1	62.1	92.1	2
666 (2%)	120	61	107	118	48.6	87.0	98.1	3
Genicide "A" (2%)	90	9	28	48	10	31.0	53.3	12
1068 + DDT (5%) (15%)	30	3	17	28	10	56.6	93.3	0
Check	165	0	0	8	0	0	4.8	36

Summary of results with Dendroctonus brevicomis Lec.
(Based on Tables IV and V)

Table VII

Materials	Tot.No. of attacks	Total No. of Dead 12hrs.	24hrs.	48hrs.	72hrs.	Average % Kill 12hrs.	24hrs.	48hrs.	72hrs.	No. of attacks
DDT-Diesel (15%)	75	2	4	23	63	2.6	5.3	30.6	84.0	0
DDT-Kerosene (15%)	105	0	7	61	--	0	6.71	58.0	--	0
DDT-Water (12.5%)	75	1	1	20	54	1.3	1.3	26.6	72.0	0
DDD (15%)	75	0	1	5	22	0	1.3	6.6	29.3	2
1068 (5%)	75	1	1	34	19/30	1.3	1.3	45.3	63.3	2
666 (2%)	75	1	5	33	--	1.3	6.6	44.0	--	0
Genicide "A" (2%)	45	2	4	10	--	4.4	8.8	22.2	--	6
1068 + DDT (5%) (15%)	75	1	5	45	--	1.3	6.6	60.0	--	0
Check	125	0	2	5	--	0	1.6	4.0	--	14

Discussion

While not enough data has been presented here to consider these tests conclusive, nevertheless, some interesting observations have been made which may justify a further study of this nature.

Several of the insecticides used were markedly inferior to the others. Thus, DDD and Genicide proved to be less effective than DDT, 666 and 1068 (Tables VI, VII).

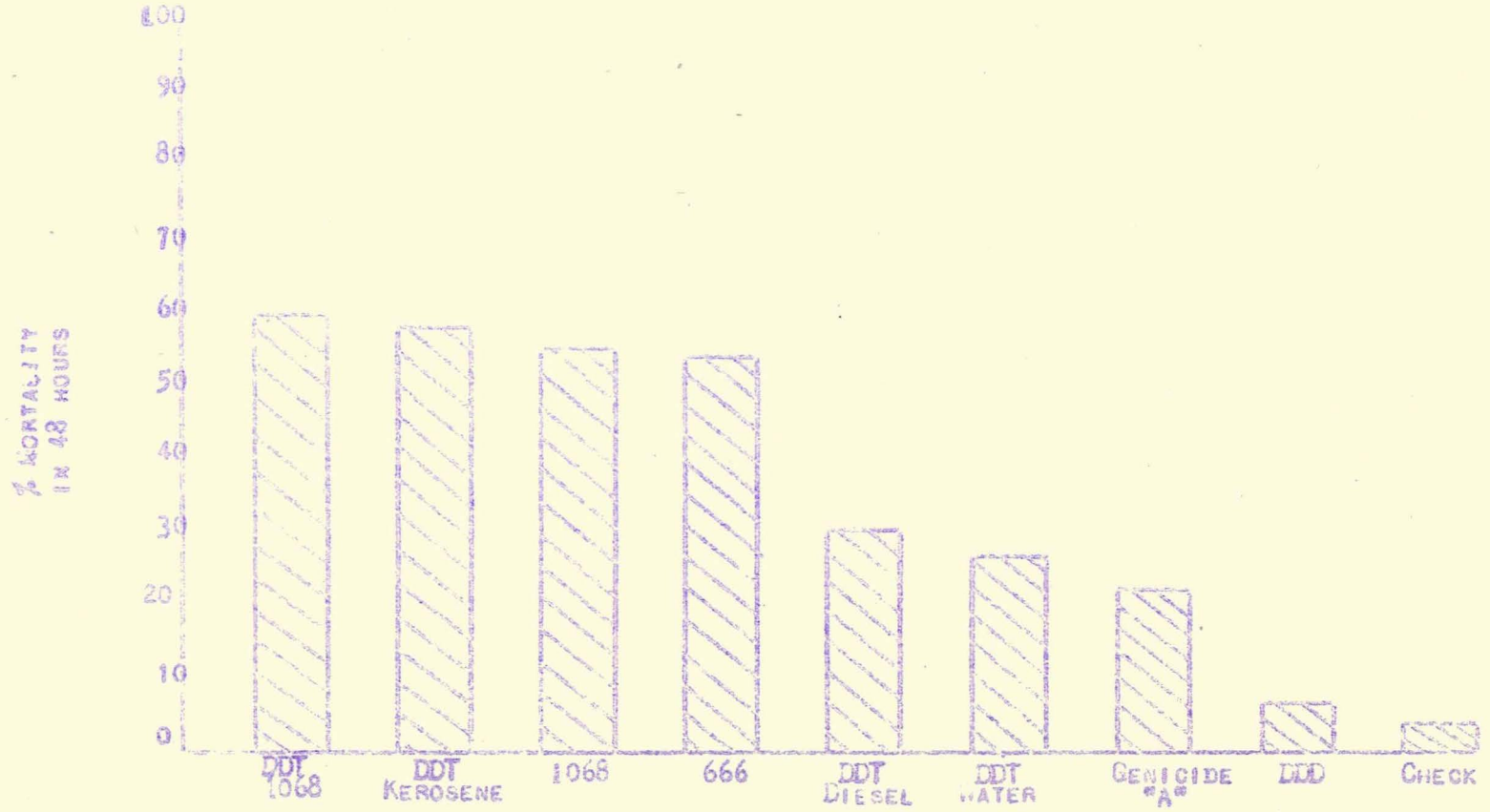
An important point to remember here is that for this type of control work an insecticide can be considered effective only if it has a good residual effect over a period of at least as long as that required for the emergence of the adult beetles. Since the experiments carried in this investigation covered only a period of 2 to 3 days, an evaluation o of the insecticides from this standpoint cannot be made at this time.

Whereas, relatively more is known about the lasting quality of DDT residues, very little is known about the residual effect of 1068 and 666 over a longer period of time. 1068 and 666 proved to be effective over a period of 5 to 6 days (Tables VI, VII), but beyond that their residual effect on bark beetles is not known.

An interesting observation was made on the Western pine beetles. All the insecticides tried on Ips confusus proved to be less effective on D. brevicomis over the same period of time (compare tables VI and VII). Whether or not this is a matter of resistance to the insecticides in question is not known. It was observed, however, that D. brevicomis was more sluggish in its habits than Ips confusus under the conditions of the tests. In contrast with Ips confusus which was active and moved about freely and forced several attacks in some instances, D. brevicomis lay flat on its back most of the time and showed little activity. It is, perhaps, this inactivity on the part of D. brevicomis that makes the insecticides less effective. The mortality rate of D. brevicomis more than doubled on the third day, but even then it was not at par with the % mortality of Ips confusus in the second day (Tables VI and VII).

In all cases the checks showed a very low mortality and forced attacks were established within 12 hours.

RESIDUAL EFFECT OF VARIOUS INSECTICIDES
ON THE WESTERN PINE BEETLE
DENDROCTONUS BREVICOMIS LEC.



RESIDUAL EFFECT OF VARIOUS INSECTICIDES
ON THE CALIF. FIVE-SPINED ENGRAVER BEETLE
IPS CONFUSUS (LEC.)